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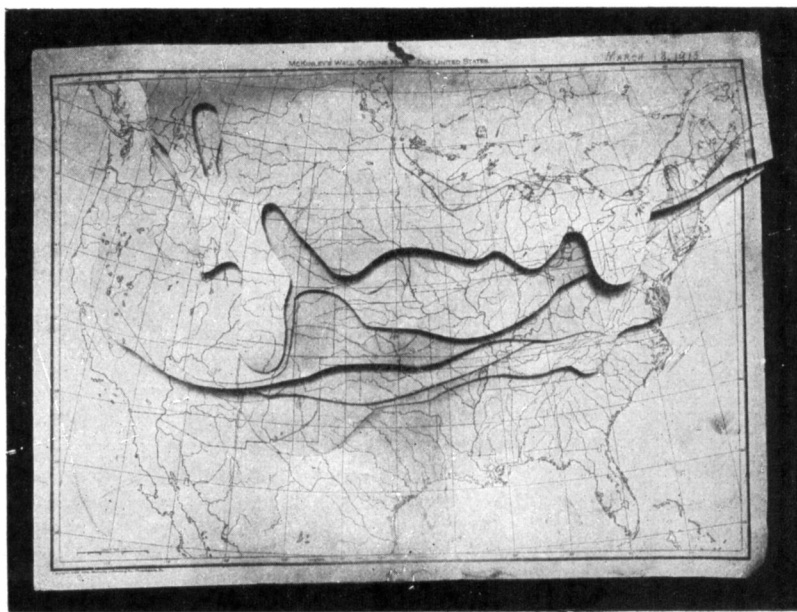
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PREPARATION OF AN EXERCISE ON THE GREAT ICE SHEET

HERMAN T. LUKENS

A geography exercise was given by the fifth grade, comparing the present winter's snow sheet with the Great Ice Sheet of the Glacial Epoch.

The preparation of this morning exercise was radically different from that of the exercise on historical methods in arithmetic. Here I had already spoken to the children about the exercise a month in advance; told them what I proposed to have them do; and described



Cut-out Map of Snow Sheet

to them the material I proposed to use. They had been chalking out on the floor map¹ the boundary of the winter ice and snow sheet as shown from week to week by the Ice and Snow Bulletin. I proposed to them to use a large wall map for the morning exercise, with a cut-out

¹ The floor of the class room is covered with linoleum in which is worked out a map of the northern half of the western hemisphere from the equator northward on a scale of twenty miles to an inch. The map is tooled out, and boundaries, mountains, cities, etc., are marked by tack heads of different shapes and sizes. The water is painted in blue and drainage features in different colors. One use for this outline map is to chalk in temporarily any historical, scientific, commercial, or geographic data.

flap to hang down from the top of the map to cover as much of the map as the snow covered of the country. I proposed to them to make a comparison between the annual snow sheet and the Great Ice Sheet of geologic times and to point out clearly wherein they are similar, and just as clearly wherein they are totally unlike.

We proceeded with the preparation of the material and added a cut-out map of the snow sheet for each week through the winter.

We had no date assigned for the exercise until we were sure of the material. A sudden emergency, a few days later, that prevented the giving of a high-school morning exercise, offered us a date two weeks earlier than before had been chosen. We had but two days' notice of the change, but the weather furnished the setting that we needed. The snow sheet was still on the ground, the floods were attracting everyone's attention to the Ohio valley, and the snow was still nearly four feet deep in northern Michigan. The exercise given was as reported below.

THE GREAT ICE SHEET

Mary. This weekly Snow and Ice Bulletin¹ shows the present winter's snow sheet. There are three places where the snow collects the deepest: Maine and New York, the northern peninsula of Michigan, and the Rocky Mountains. On March 18 in Maine the snow was 19 inches deep, in New York 3 inches, in Michigan 41 inches, and in the Rocky Mountains 14 inches. This printed part down below tells where the storms are, and this table tells how deep the ice is in the rivers.

Lee. The Great Ice Sheet came many thousands of years ago. The edge of the Ice Sheet was along the Ohio and the Missouri rivers. These (*pointing to diagram*) are the three great centers where the ice was thickest. This one is called the Labrador, this the Keewatin, and this the Cordilleran Ice Sheet.

There are many traces of the Ice Sheet around Chicago. One is the great granite boulders that the Ice Sheet brought down from Canada. On the rocks at Stony Island there are scratches and grooves that the ice made as it passed over that region. The terminal moraine is another trace. This moraine was formed of earth deposited at the edge of the ice. The edge of the Ice Sheet stayed for many years at the same place, and all the earth that was brought down in the ice collected there, and so that formed the moraine.

Halloween. This morning some of the fifth-grade children are going to take this winter's snow sheet in comparison with the Ice Sheet of long ago. The Great Ice Sheet was thousands of feet thick. This winter's snow sheet varies from inches to a few feet. These two charts show the extent and depth of this winter's snow sheet, and the extent and movement of the Great Ice Sheet at the period of its greatest extent. The farthest that the Ice Sheet ever came is right along here (*pointing to the diagram*).

When the snow sheet extends further than the Ice Sheet extended, it is not very deep.

¹ Published weekly during the winter by the Weather Bureau.

Theresa. The material of both the winter snow sheet and the Great Ice Sheet that came long ago is snow. Thousands of years ago, at the time of the Ice Sheet, it snowed very heavily, and as it was always cold, there was no chance for the snow to melt, and that is how an ice sheet was formed. Here is a chart of the Ice Sheet. Here is where the snow sheet was melting back. On March 13 the snow had melted back quite a little. Down here in Texas is the farthest it came at any time this winter. In here there was an island of bare land with no snow on it. The first chart is for December 10, and the snow came down only a little way over the Great Lakes region.



Map of Great Ice Sheet

You can see over here that Cape Cod was never covered with snow. Down in Texas it was not very deep, but the Great Lakes region was always covered. The places where it was deepest were in Maine, Northern Michigan and the Rocky Mountains. At places in the Rocky Mountains there is snow almost all the year around.

Carolyn. As the winter snow sheet retreats, the birds that have gone south come back, and the animals come back. The Ice Sheet retreated in the same way that the winter snow sheet does. When the Ice Sheet came, the birds went south too. As the Ice Sheet retreated, some plants came back and are still on their way north. Some of the trees and other plants that used to grow about here grow now in the Hudson Bay country. When the Ice Sheet re-

treated, the Ohio, the Mississippi, and the Missouri rivers were developed by the great amount of water from the melting ice.

Theresa. I forgot to say that the Ice Sheet and the snow sheet extend from the south pole in a similar way as from the north pole.

Lucile. This is a map of the United States, and shows the snow sheet for this winter only. (*This was a cut-out chart showing, by a series of cut maps lying one over the other, the weekly changes in the snow sheet for the present winter. See the first cut in this article.*)

Allan (pointing to the Ice Sheet map). The Ice Sheet, on the other hand, lasted many thousands of years. Since it lasted year after year, it grew much thicker than the snow sheet that lasts only for one winter.

Lucile (showing diagrams). These curves show the depth of snow in the Michigan Peninsula, in Colorado, and in Maine, from week to week throughout the winter.

Allan. The immense thickness of the Ice Sheet made it flow because the pressure of the ice pushed it out from the middle, and it flowed in all directions, and while it flowed it grew thicker. It would go over mountains and take the top off and carry the earth and boulders and dirt and things

and would pile them up in the valleys, and make rivers and lakes. On class excursions we have seen boulders that have come from Canada in the ice.

Lucile. Instead of making lakes, as the Ice Sheet did, the snow melts and leaves ponds and pools that last only a few days. The mud that has been mixed up with the snow covers everything outdoors, and the streets have to be cleaned, but the snow cannot carry the mud any great distance.

Allan. No plants could grow in the country covered by the Ice Sheet, and the animals could not get food, and they had to go south, and when it retreated, they came north again. This northward retreat is still going on now. There are lots of plants and animals that are away up in Canada now, whose ancestors used to be around here.

Lucile. Some birds and animals go south each winter when the snow sheet comes. There are plants, annuals, that are killed during the winter, but they come up again from the seeds. Others do not die out, perennials, and, when the snow goes, then the birds and other animals come north again.

Dr. Lukens. This completes our exercise, but there are some parts of it that did not come out, although most of the points we had in mind have been presented. It has been our intention for some weeks to have an exercise on the Ice Sheet before the snow went away from this region. The retreat of the snow sheet has presented itself this spring in a very striking way in Indiana, Iowa, and Ohio. The terrific catastrophe of this year is a vivid example of those that occurred as the Ice Sheet retreated. The comparison between the Ice Sheet and snow sheet is very suggestive. We do not find this enlarged upon in the books. The comparison that is enlarged upon by the geologists is between glaciers and the Ice Sheet. The latter is frequently called a glacier. Now, it differs just as radically from a glacier as it does from the snow sheet, and the difference needs to be understood. I have chosen this morning's exercise to show the neglected comparison between the snow sheet and the Ice Sheet. The essential difference is that the snow sheet does not flow as the Ice Sheet did. If you bear that one difference in mind you may think of the Ice Sheet as a great perennial snow sheet. The materials are the same and came in the same way, but the Ice Sheet lasted longer. This is the real cause of the difference. The Ice Sheet carried earth material with it, and with this it mantled the land and filled the valleys and scraped off the tops of mountains and blocked up valleys already there. This action of the ice in motion can be studied best by observing the glaciers of the present.

Halloween. I forgot to say that the seasonal climate changes here about every day or so, but in the days of the Ice Sheet the changes were by the thousand years—about a thousand years of bad weather and a thousand years of good weather.

Macaulay (sixth grade). Do you know when we will have another Ice Sheet?

Dr. Lukens. We must first know what caused this Ice Sheet. If we find out what caused that, we can probably say when it will return. The theories are so uncertain that it is better not to deal with them at all. The theory that has the most confidence at the present time, is that the variation of climate is due to the carbon dioxide in the atmosphere. The amount of carbon dioxide in the atmosphere determines its power to take and retain the heat from the sun's rays as they pass through it. As the sun's rays pass

through space no heat is taken, but as they reach the atmosphere of the earth, it acts as a net to catch and absorb the heat. Carbon dioxide increases very much the power of the atmosphere to absorb the sun's rays. A slight depletion in the amount of carbon dioxide in the atmosphere would suffice to produce a profound change of climate.

Miss Leubrie. What about the theory of the change of the axis of the earth?

Dr. Lukens. The axis of the earth is wobbling in a cycle of several thousand years, and this might account for the difference in climate. If the axis of the earth were more nearly perpendicular to the ecliptic, it would be much colder at the poles. We should perhaps have said that the greatest ice sheet at present is around the south pole—the ice sheet that has been explored by Shackleton, Ross, and Scott. That ice sheet covers the entire Antarctic continent. In the north, the greatest ice sheet is in Greenland. There we can study the ice sheet growing to great thickness in the interior. Greenland is without vegetation, except along the coast, the snow and ice covering the entire land.

Miss Leubrie. Wallace's *Island Life* is a classical work on this subject.

Miss Cooke. The melting of the snow sheet has brought about a great deal of suffering this year, especially to some of our neighbors in Indiana, Ohio, and Nebraska, and there has been a call from the United Charities for help. Men, women, and children are almost without clothing. Money also is needed. Bring tomorrow any help that you want to give, whether in clothing or money. I know, of course, that at Thanksgiving and Christmas you gave all the clothing you could spare, but perhaps some has accumulated since. The United Charities have facilities by which they can get things to places where they are needed.